

Online Resource ESM_1

In the main text of the article, we explore the fundamental biology, ecology, genetics and microbiomics of mosquito species in a scoping review that brings together recent research. The review article focuses on mosquitoes, and to extend the scope of the synthesis to hematophagous arthropods, we are providing the reader with additional information on ticks. Further efforts are encouraged to provide the community with a dedicated review of the existing knowledge on these models, and to highlight the research opportunities which must be developed to improve our understanding of invasion success in ticks.

(1) Ecological characters of invasive ticks

The non-native tick *Rhipicephalus microplus*, introduced in 1942 in New-Caledonia, quickly fed on cattle of European origin, considered as a 'natural' host for the tick (Chevillon et al. 2013). In parallel, the ticks also developed on *Java rusa*, a deer species native to the islands of Indonesia and deliberately introduced in New-Caledonia during the 19th century. Interestingly, the deer is not a 'natural' host for this tick species, because of an effective immune response that disrupts the tick fixation. Nevertheless, female ticks which do succeed have been documented to produce a larger number of offspring than ticks feeding on cattle (Barré et al. 2001). The explanation of this apparent paradox came from a population genetics study that demonstrated a strong genetic divergence between populations feeding on cattle versus populations feeding on deer (De Meeûs et al. 2010). This intriguing finding suggests that host-specific incipient breeds can emerge rapidly — within a 60-year time span in this study. In turn, this has implications for dominant hosts of other arbovirus vectors, which could shift disease dynamics over time and cause the emergence of other pathogens in novel hosts. The potential for such a shift in feeding behaviours should be examined and reported in other invasive hematophagous arthropods.

(2) Ecological niche shifts

There remains a paucity of information regarding possible shifts in the ecological niches occupied by invasive ticks, and most other hematophagous arthropod vectors. The few available studies have focused on gradual abandonment of agricultural lands, which resulted in the extension of forested areas, especially in temperate western Europe over the past two centuries (Kirby and Watkins 1998; Jamoneau et al. 2010). In these situations, a transformation in rural landscapes has increased the numbers of roe deer, a common host for the *Ixodes ricinus* tick, and the most frequent tick species in Europe (Sprong et al. 2020). Molecular analysis showed that *Ixodes scapularis* expands its ecological range by progressive adaptation and migration into newly colonized habitats (Khatchikian et al. 2015), while bird migration also plays an important role in dispersion routes (Talbot et al. 2019). Finally, the tick *Rhipicephalus microplus* was also able to shift its feeding behavior to new hosts (Chevillon et al. 2013).

(3) Competitive ability and trophic interactions

An example of competitive exclusion is provided by the invasive tick *R. microplus* which displaced its native sister-species *Rhipicephalus decoloratus* (Chevillon and Hubert 2015) in southern Africa. This exclusion is likely supported by a fecundity advantage, a different life cycle length, a lower cost of acaricide resistance or the existence of a parasite, common to both species but conferring an advantage to *R. microplus* (Horak et al. 2009; Nyangiwe et al. 2013).

In ticks, the impact of the type and quality of the resource (*i.e.* host quality/pedigree) on the fitness and performance of individuals is rarely documented (Fracasso et al. 2022). Nevertheless, host body size systematically emerges as one of the most important host parameters driving tick abundance and diversity, with larger hosts having higher tick burdens (Esser et al. 2016). Intraspecific variations in host age, sex and haematocrit were also reported to affect tick performance variables (Fracasso et al 2022). Further examples include the invasive shrub *Rosa multiflora*, whose direct and indirect positive effects on tick populations (Walter et al. 2016) increase human disease risk, or the invasive mammal *Tamias sibiricus* that played a significant role in raising the risk of transmission of Lyme borreliosis through tick exchange (Marchant et al. 2017). In some instances, invasive earthworms, which modify soil litter structure, have been shown to reduce the density of *Ixodes scapularis* (Burtis et al. 2014).

Network approaches based on meta-analysis quantify more than 14 000 interactions in ticks, hosts and pathogens (Estrada-Peña et al. 2015, 2016) and demonstrated that the network is highly robust because of the important number of vertebrates involved, while ticks and vertebrates interactions are structured by the environment and interactions mediated by pathogens follow a phylogenetic structure (Estrada-Peña et al. 2015).

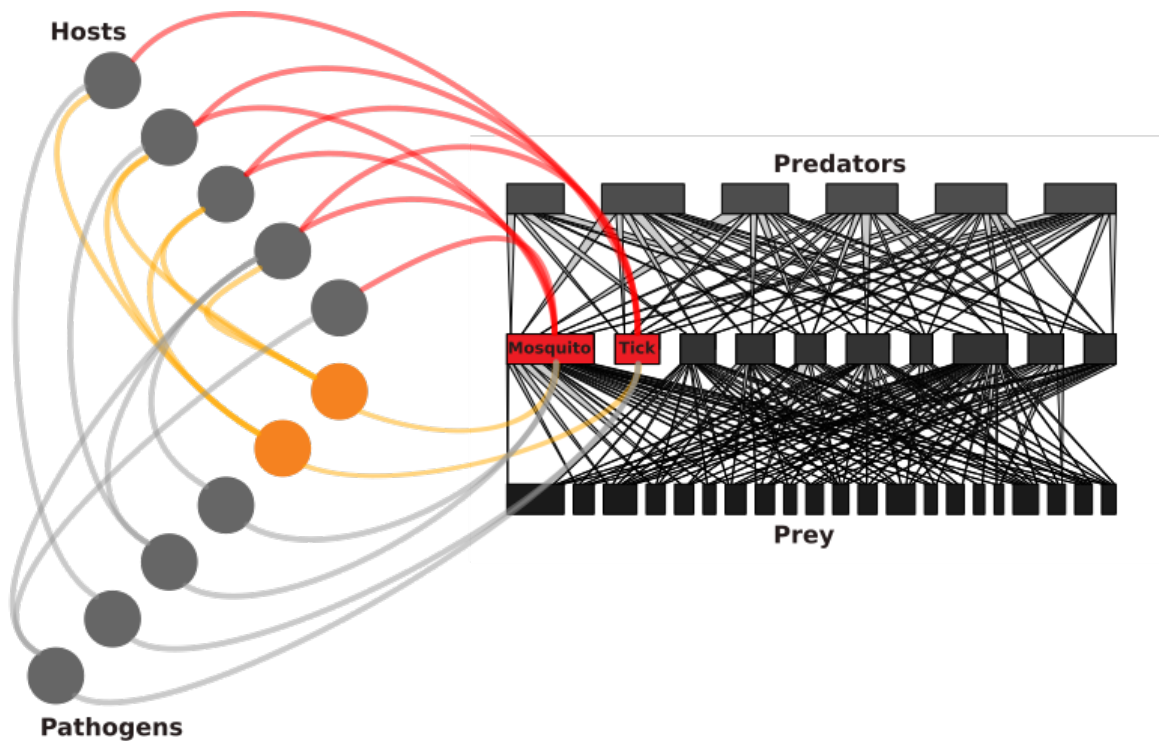


Figure 1. A theoretical simplified multilayer network with hematophagous arthropods, represented in red. Here a mosquito and a tick species are used as examples. In the qualitative network on the left, human diseases and their pathways are represented in orange. In the quantitative network on the right, mosquito and tick species are predated by top trophic level predators (e.g. birds). The mosquito species (and other species from the middle trophic level) consumes prey from the first

trophic level during the larval life stage. Each species is represented by a rectangle proportional to the abundance. The width of each interaction is proportional to the frequency of the interaction.

In the same way, the flexibility of microbial communities in ticks also raises questions about the impact of these variations on tick biology (Bonnet et al. 2017). To that end, further studies are needed to determine how ticks acquire their microbiota, and how the composition and diversity of microbial communities are shaped by environmental and host factors and may constrain successful adaptation to new environments.

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